

# Semantic Routing and Application Based Networking Evolution not Revolution

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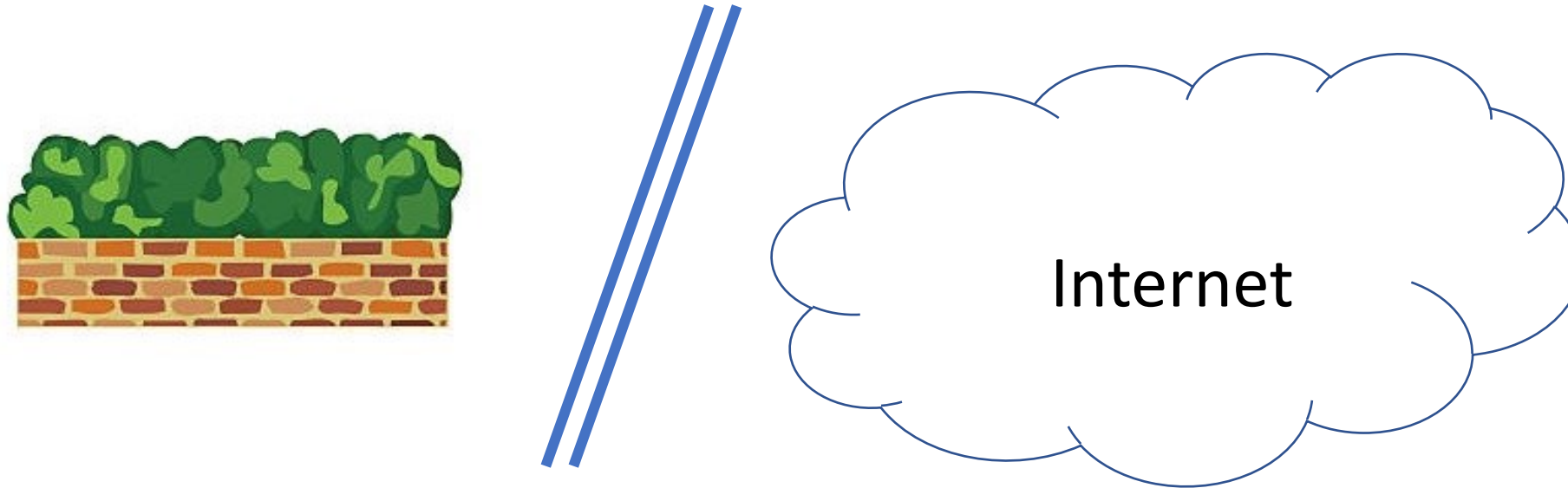
# We need to future-proof the Internet

- New applications really are coming
  - In October 2021, Cisco announced “holographic conferencing”
  - Also in October 2021 Facebook planned to rebrand as Meta and develop the Metaverse
  - LAN gaming centres in China can have more than 2000 seats
  - VR and AR equipment is affordable for the home market
  - Nearly everything is moving to the cloud
- Rapid advances in connectivity technology enable new thinking
  - Fibre to the premises is a reality even in backwards countries like the UK
  - 5G offers significant bandwidth improvements
  - LEO deployments are literally taking off
  - Cheap WiFi-enabled IoT devices are commonplace
- Thus, we’re not talking about a far-distant future
- Requirements have been clearly expressed
  - *Bigger, better, faster, cheaper* – Geoff Huston, October 2021
  - Turn the IP network from “best effort” to something better
  - More deterministic
  - More predictable service behaviours
  - Better coordination with needs of applications
  - Enable new services and new revenue models
- For many people, the Internet is just the applications running over it, but we care about the network
  - **Better than best effort**
  - **Routing beyond reachability**



# Deployment Architecture Is Important

## 1. Walled Garden



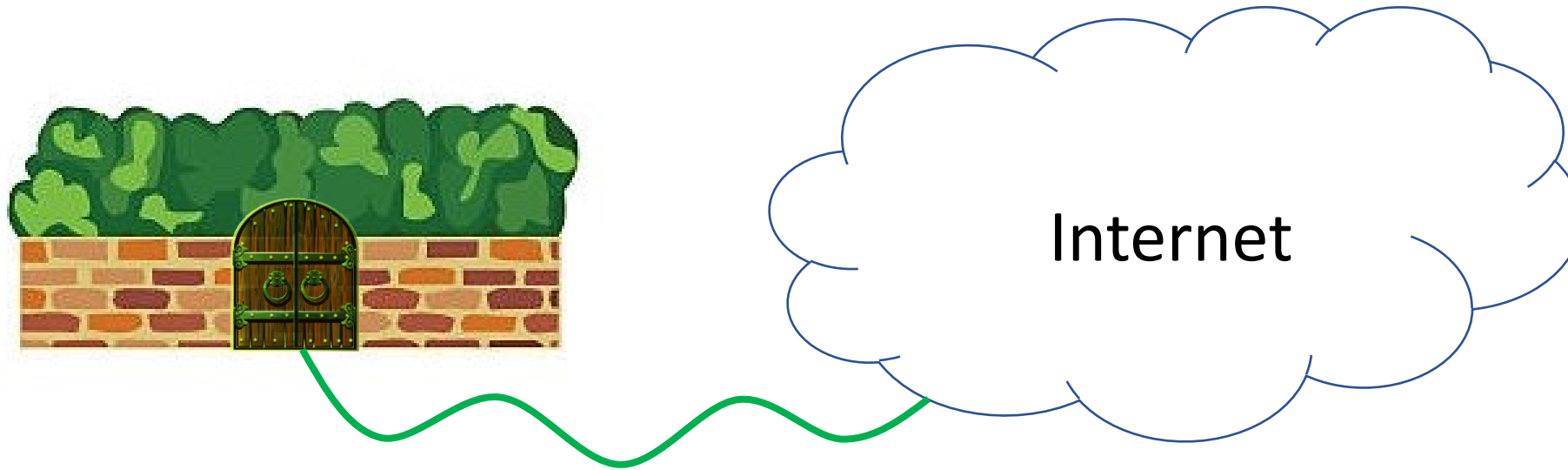
Do what you want in the privacy of your own network

But...

- May be limited who can supply you equipment
- You can never talk to anyone else

# Deployment Architecture Is Important

## 2. Walled Garden With a Gateway : Protocol mapping



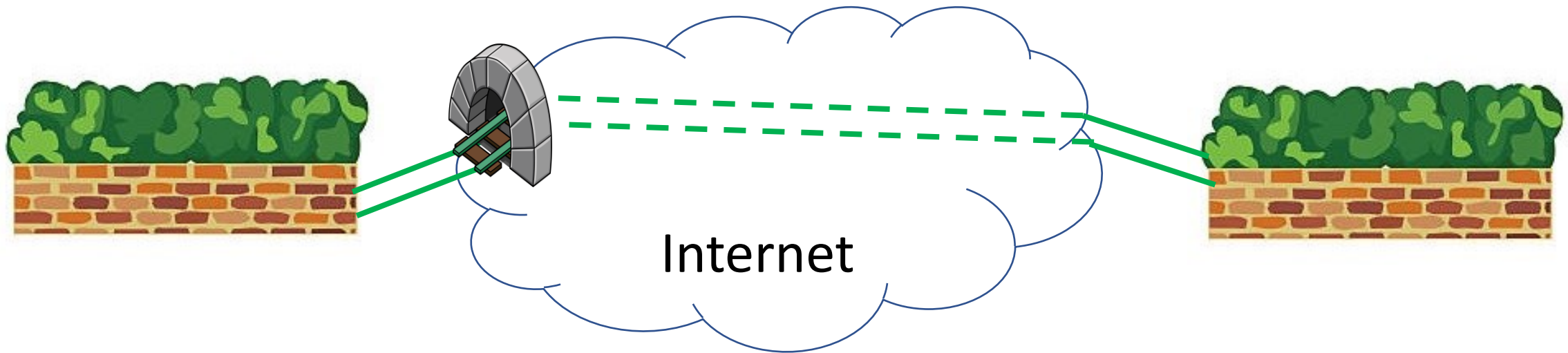
Do what you want in the privacy of your own network

But...

- Convert back and forwards to standard Internet protocols
- Adds complexity and cost

# Deployment Architecture Is Important

## 3. Inter-Connected Walled Gardens : Tunnel



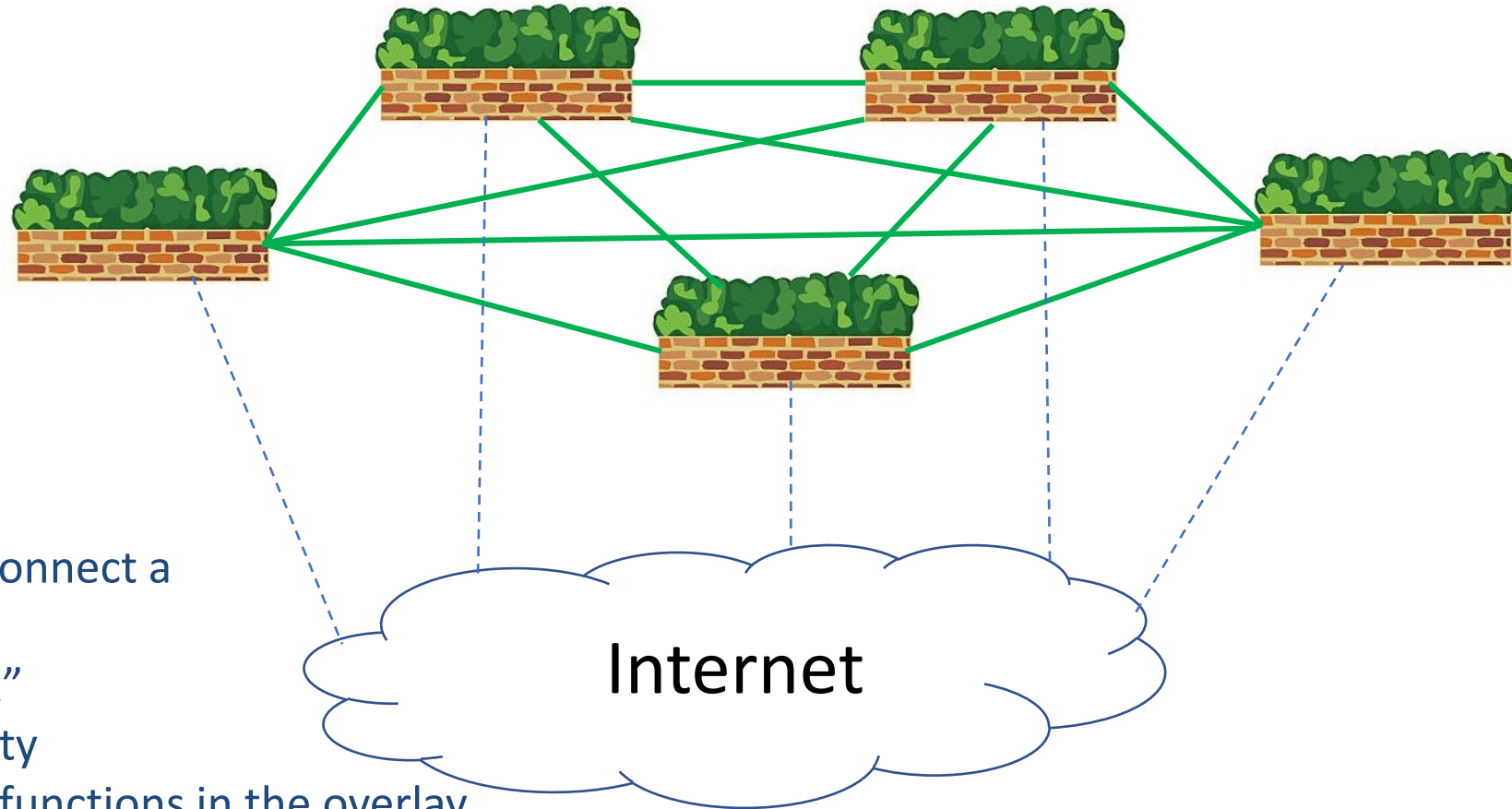
Cooperating private networks tunnelled over the Internet

But...

- There is an “encapsulation tax”
- Operational management might not scale well

# Deployment Architecture Is Important

## 4. Overlay Mesh Networks : Connected walled gardens - lots of tunnels

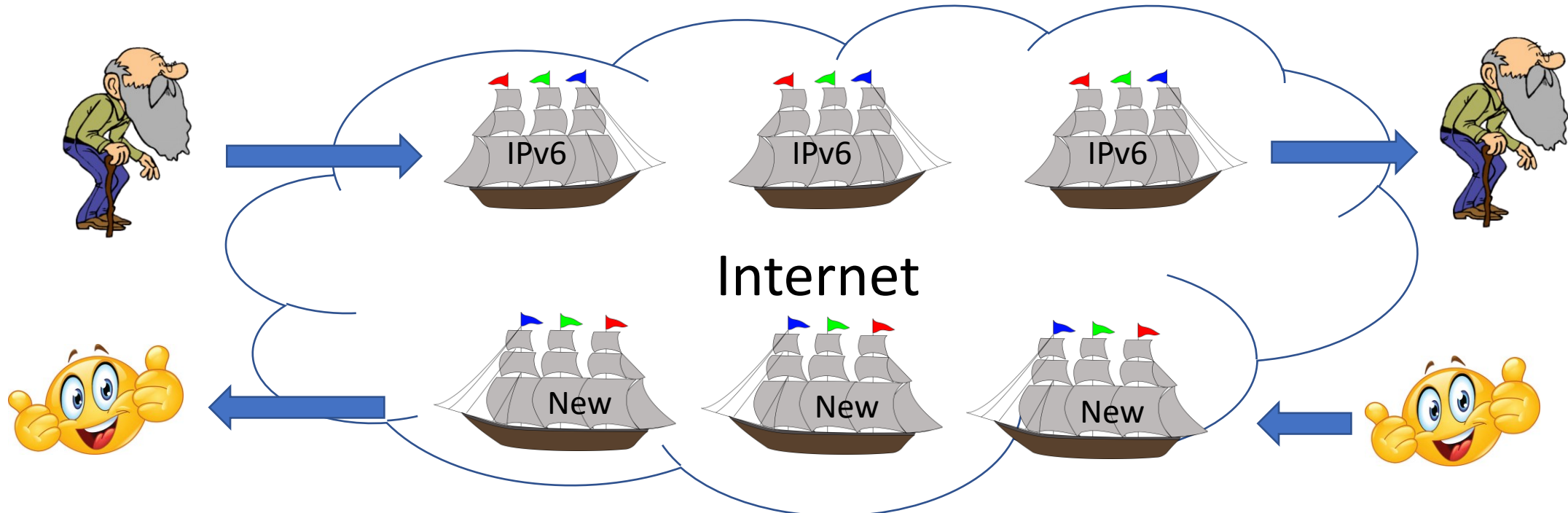


Use the Internet as plumbing to connect a new network of sites

- Still pay the “encapsulation tax”
- Still have operational complexity
- Can easily add new and clever functions in the overlay
- Not addressing the performance and behaviour we want from the Internet

# Deployment Architecture Is Important

## 5. Ships That Pass In the Night : Seamless Co-existence

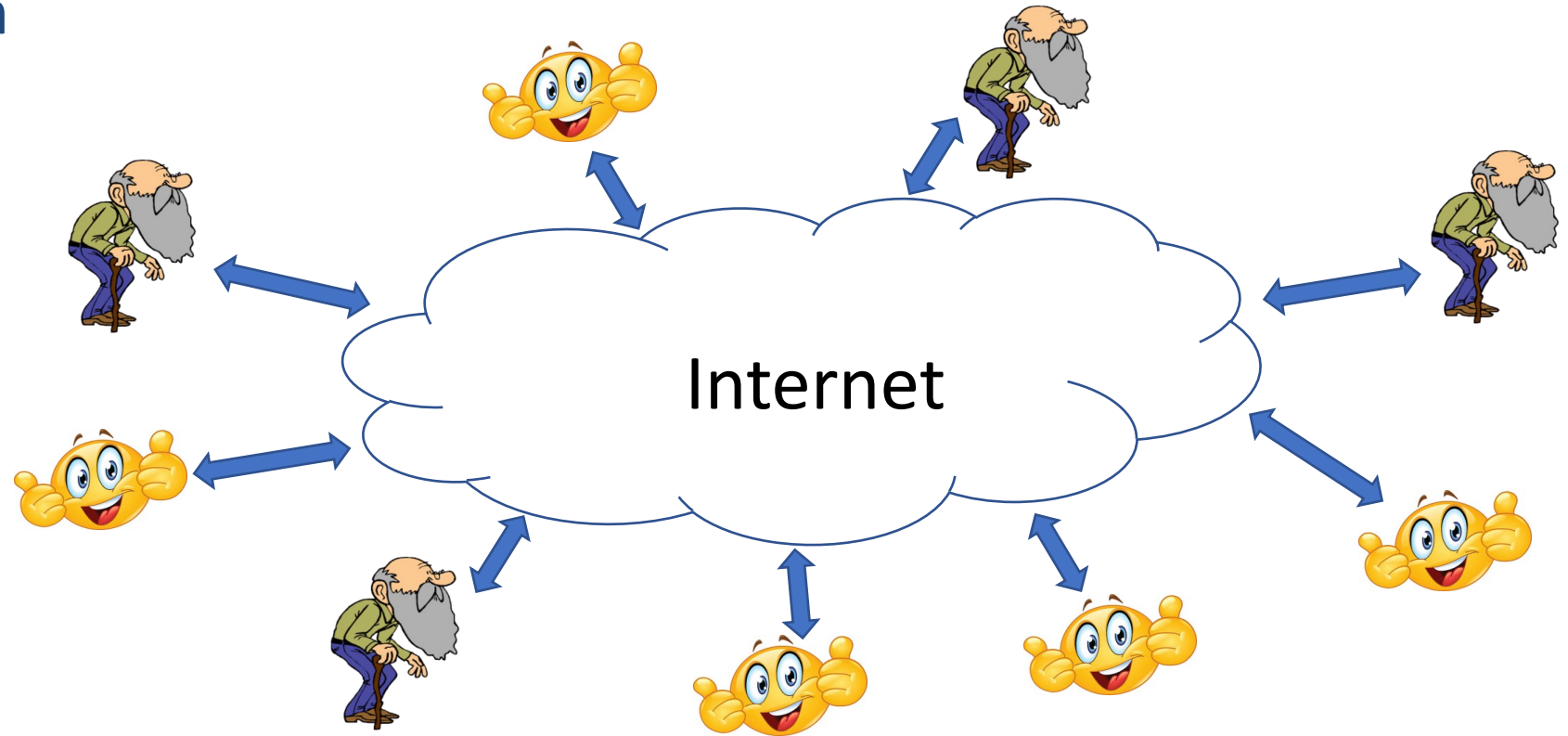


Introduce new features in a backwards-compatible way

- Old function is not disturbed
- New function can do clever stuff
- May be operationally complex

# Deployment Architecture Is Important

## 6. Full Integration



- Extensibility allows new functions
- Interoperability with new and old implementations
- What we have learnt in the last 30 years



# Concerns and Panic



- Changes to routing and forwarding bring many risks
  - These are minimised in closed systems
  - But we don't want closed systems
- Deployability
- Manageability and Operability
- Stability
- Scalability
- Interoperability
- Extensibility
- Privacy
- Security
- Read more at [draft-king-irtf-challenges-in-routing](#)

# Application Aware Networking (APN)

- A way to mark packets depending on the per-hop behaviour needed from the network
- Markings may identify
  - Conventional Quality of Service
  - Extended QoS
  - Class of application
  - Class of user
- Sometimes called “DiffServ on Steroids”
  - Changes how packets are prioritised, queued, and given access to resources
  - Does not change how packets are steered/routed/forwarded
- May work well on devices with large number of queues
- Getting a lot of discussion in the IETF, but currently pre-standardisation

# Semantic Networking

- An umbrella term to cover many technologies with a general theme...
  - Making routing/forwarding decisions based on more information not normally used for those purposes
- Semantic Routing determines new paths through the network based on service characteristics
  - Can be centralised (SDN) or distributed (like IGPs)
- Packets are marked for different forwarding treatment
  - Use existing packet fields
    - Repurpose part of an IPv6 address
    - Use existing flow identification fields (five-tuple, ToS, TC, Flow Label, payload, etc.)
    - “Overload” existing fields giving them new meanings
  - Information may be carried in new fields
    - IPv6 Extension Headers, new “Layer 3.5” encapsulation, new MPLS Special Purpose Labels with ancillary data
- Make forwarding decisions based on routing algorithms and packet marking
  - Allows a packet to be sent on the best path according to the services it needs
  - May use a forwarding table programmed by the routing system
  - Could use a complex and dynamic forwarding algorithm
- See [draft-farrel-introduction-to-semantic-routing](#)

# Evolution Not Revolution



- History tells us that Internet Revolutions are hard
  - Not impossible, but look at IPv6
- Layering is a way to make this easier
  - MPLS and layer 3.5
- Changes are easiest with “end-to-end” protocols
  - Lots of innovation in the application layer
  - QUIC
- But we want/need changes at the packet layer
- Think about
  - The politics
  - The money
  - The complexity

# My Conclusions

- We need new ways to make the Internet deterministic
  - Applications need to be able to say what they need
- We need new function at the network layer
  - Adding overlays may help a lot
    - But they don't address the fundamental hop-by-hop issues of performance
- We must evolve to allow support of the huge deployed base
- Anything new must be extensible
  - We don't have all the answers
- Keep it Simple!